

CONSERVATION SECTION

CONSERVATION STATUS OF BIRDS OF CENTRAL PACIFIC ISLANDS^{1,2}

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In the course of investigations conducted by the Pacific Ocean Biological Survey Program (POBSP) of the Smithsonian Institution, field workers paid visits to a large number of islands in the central Pacific Ocean, many of which are or were important because of the abundance of their bird resources. Visits to many central Pacific islands by biologists have been infrequent, and reports on the conservation status of the biota are difficult to glean from the meagre published information currently available. Berger (1972) has reported on the status of birds from the main Hawaiian Islands, so these will not be discussed here.

Figure 1 depicts the islands or island groups discussed in this report. Most of this report is based on surveys conducted between 1963 and 1968; in a few instances the information is current to 1972.

The report will stress man's influence on the islands, even though in some instances it would be difficult to show direct causal relationships between man's activities and deterioration of the bird fauna. In other instances it is all too blatant. I will also indicate where avian predators or potential predators have been introduced, as far as is known. Finally, I will point out where populations of birds are of more than passing significance in terms of the central Pacific breeding avifauna as a whole. There are few landbirds in this area but the seabird populations are vast and varied. This report will stress the status of the latter.

In general, among seabirds, the shearwaters, petrels, and storm petrels are the most sensitive to disturbance and predation. Ground-nesting tropicbirds, terns, boobies, and frigatebirds are somewhat less sensitive, while the tree-nesting boobies, frigatebirds, and noddies are least sensitive. A rapid assessment of the relative health of an island as a seabird habitat may be made by comparing the species representation in these three groups with the species one might predict would occur on an island taking into account climate, vegetation, and terrain. King (1967) lists the seabirds known to occur in the island groups covered in this report.

NORTHWESTERN HAWAIIAN CHAIN

Theodore Roosevelt proclaimed the Northwestern or Leeward Hawaiian Chain a wildlife refuge in 1909, since which time it has enjoyed relative stability and protection. Seven islands comprise the Hawaiian Islands National Wildlife Refuge. The refuge is administered from Oahu with actual visits to the refuge once or twice a year, dependent upon the cooperation of the U.S. Coast Guard. The administrator has no boat to patrol the islands over which he has jurisdiction.

Nihoa (0.25 square miles).—Nihoa has two endemic landbirds, the Nihoa Finch (*Psit-*

¹ As indicated in the June 1972 issue of *The Bulletin* (84:222) the Conservation Committee of the Wilson Ornithological Society decided to concentrate for this year on bird conservation problems in the Pacific Islands. This report is the second contribution from the committee on this subject.—GUSTAV A. SWANSON, *Chairman*.

² Paper No. 88, Pacific Ocean Biological Survey Program.

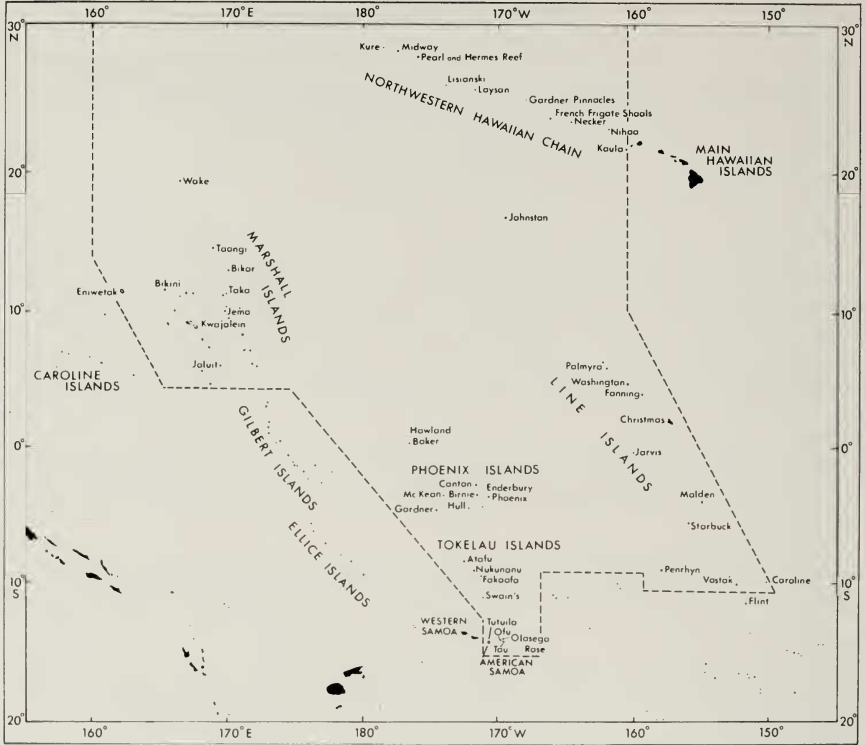


FIG. 1. Islands of the central Pacific Ocean. Islands within dashed perimeter are included in this report.

tirostra cantans ultima) and the Millerbird (*Acrocephalus familiaris kingi*), both listed as endangered by the U.S. Department of Interior (1966). The population estimate for 1971 of the former is in the low thousands, and of the latter in the low hundreds (J. Sincock, pers. comm.). Both populations are thought to be stable, and the habitat may be saturated.

In addition Nihoa has representative populations of all the seabird species that are found throughout the Northwestern Chain. Of special significance are its population of Bulwer's Petrel (*Bulweria bulwerii*), estimated at up to 250,000, the largest known population of this species in Hawaii, and perhaps in the world; Great Frigatebirds (*Fregata minor*) estimated at 10,000; up to 25,000 Wedge-tailed Shearwaters (*Puffinus pacificus*), and up to 100,000 Sooty Terns (*Sterna fuscata*) (Clapp, Kridler, and Fleet, in prep.). There are no introduced predators on Nihoa.

Although unauthorized visits to this island are kept to a minimum because landing is difficult, personnel from a U.S. Navy vessel recently placed a sign near the top of the island announcing their visit.

Necker (0.07 square miles).—Necker Island is smaller than Nihoa, has no landbirds, and supports smaller numbers of the same seabirds that breed on Nihoa. Fifty thousand

Sooty Terns breed on Necker (Clapp and Kridler, in prep.). It is equally difficult of access, and is less frequently visited than Nihoa.

French Frigate Shoals (0.17 square miles).—French Frigate Shoals is a group of 13 islands, the largest of which, Tern Island, is the site of a U.S. Coast Guard LORAN A Station. Tern Island, now half of the land area of French Frigate Shoals, is mostly man-made, having been enlarged from 11 acres to 56.8 acres in 1942 for a U.S. Navy Air Facility; it now accommodates the station, a runway, and a 129-foot antenna (almost no bird mortality has been caused by this tower). Nineteen Coast Guard personnel inhabit Tern Island. The Coast Guard facility was formerly on East Island, but that island is now abandoned and seabirds breed there again in large numbers. A written agreement drawn up in 1965 between the Coast Guard and the U.S. Bureau of Sport Fisheries and Wildlife forbids use of any but Tern Island by the Coast Guard. Between 1952, when the Station moved from East to Tern Island, and 1965, there was apparently no formal agreement about the use of the refuge by the Coast Guard. Coast Guard personnel have been permitted to keep dogs (three are presently on the island), and at one time or another, but not presently, cats and pigs were present as well. The dogs are restricted to Tern Island, where they occasionally harass green sea turtles (*Chelonia mydas*) and Hawaiian monk seals (*Monachus schauinslandi*). French Frigate Shoals is the most important breeding site for green sea turtles in the Hawaiian Islands. Seabirds continue to breed there in undiminished numbers; a breeding population of 120,000 Sooty Terns is present. No rats occur there in spite of military activity.

The Refuge Manager, Eugene Kridler, introduced 27 Nihoa Finches to French Frigate Shoals in March 1967. They have nested in crevices in piles of concrete blocks near the buildings on Tern Island. The population had declined to three by 1968, but was back to nine by 1971 (Amerson, 1971).

Gardner Pinnacles (0.01 square miles).—Gardner Pinnacles is nearly impossible to land on from the sea. In 1961 or 1962 the U.S. military made an unauthorized landing on Gardner Pinnacles as part of their HIRAN project, one purpose of which was to determine the exact location of several of the Northwestern Hawaiian islands for navigational purposes. Among other activities the landing party blew the top off the island with explosives to create a flat area for future helicopter landings. Part of the work of the Refuge Manager in his 1969 inspection of Gardner Pinnacles was to clear some of the refuse left behind by the military.

Because of its small size Gardner Pinnacles has small populations of the representative sea birds, including the northernmost breeding population of the Blue-gray Noddy (*Procelsterna cerulea*) (Clapp, in press).

Laysan (1.56 square miles).—Laysan has had a colorful history which includes guano mining, feather poaching, seal killing, and egg collecting on a massive scale. It had five endemic land or water birds, two of which, the Laysan Teal (*Anas laysanensis*) and the Laysan Finch (*Psittirostra c. cantans*), survived defoliation of the island by introduced European rabbits (*Oryctolagus cuniculus*) and exist now in relatively stable numbers. The story of the extinction of the other three landbirds from Laysan is too well known to need repeating here (see, for example, Laycock, 1970). The teal fluctuates in abundance, having dropped recently to the very low hundreds in September 1971 (J. Sincock, pers. comm.). With a population of about 10,000 birds (Ely and Clapp, in press) the Laysan Finch has apparently saturated its habitat. Laysan has the largest known population of several species of seabirds: 300,000 Laysan Albatrosses (*Diomedea immutabilis*), 40,000 Black-footed Albatrosses (*Diomedea nigripes*), 200,000 Wedge-tailed Shearwaters, and 2,000 to 3,000 Sooty Storm Petrels (*Oceanodroma markhami*), the last nesting along the edge of the central lagoon in an area where storms must cause frequent

flooding of burrows. Other notable populations include several hundred thousand Bonin Petrels (*Pterodroma hypoleuca*), a Sooty Tern colony of approximately 2,000,000 birds, several thousand Red-tailed Tropicbirds (*Phaethon rubricauda*) and 1,000 Blue-faced Boobies (*Sula dactylatra*) (Ely and Clapp, in prep.).

There have been numerous authorized and unauthorized visits to Laysan. Among the latter was a U.S. Military visit in early 1963 as part of the HIRAN project. Burrgrass (*Cenchrus echinatus*) became established as a result of this visit, expanding outward concentrically from the abandoned military campsite on successive visits by POBSP or refuge personnel. The Refuge Manager has been successful in controlling this species. A second inadvertent introduction, hairy horseweed (*Conyza bonariensis*), became established in the late 1960's and promises to be more difficult to eradicate.

In 1970 a Japanese fishing vessel was shipwrecked on the reefs surrounding Laysan. The crew members lived briefly on Laysan before being rescued. The vessel was known to contain rats of uncertain species, but they may not have reached the island. The U.S. military was granted a special use permit to lay large canvas tarpaulins on Laysan and Lisianski as high resolution targets for satellite reconnaissance. The Refuge Manager collected 18 pounds of seeds of 20 species of alien plants from these tarpaulins. A letter from the Secretary of the Interior was required to convince the U.S. military that the tarpaulins should be removed.

Lisianski (0.07 square miles).—Lisianski Island has large populations of seabirds, including the largest known population of Bonin Petrel, estimated roughly at one million birds. Other notable populations include 8,000 Laysan and 3,000–4,000 Black-footed Albatrosses, a Sooty Tern colony of approximately 1,000,000 birds, and large colonies of Great Frigatebirds, Red-footed Boobies (*Sula sula*), and Red-tailed Tropicbirds. Historically there was a large population of Bulwer's Petrels, but these evidently were extirpated, or nearly so, by rabbits (Clapp and Wirtz, in prep.). Alexander Wetmore exterminated the rabbits on Laysan and Lisianski in 1923.

Pearl and Hermes Reef (0.14 square miles).—Pearl and Hermes Reef, comprised of nine islets, is presently uninhabited. A pearl-oyster gathering industry thrived between 1928 and 1930 on this atoll. The pearl fishermen built four houses which survived until World War II. Rabbits were introduced in the early 1920's but were extirpated within three years. Pearl and Hermes Reef has large populations of Bulwer's Petrels and Sooty Storm Petrels in addition to smaller populations of most of the other seabirds relative to populations on other Northwestern Hawaiian islands (Amerson, Clapp, and Wirtz, in prep.).

In 1967 the Refuge Manager transplanted 12 Laysan Teal and about 100 Laysan Finches to Southeast Island (34 acres), the largest of the atoll. The former did not survive. The latter have bred successfully and have increased to several hundred at last census in 1971 (J. Sincock, pers. comm.) and may well have saturated their habitat on Southeast Island.

In 1961 or 1962 there was an amphibious landing on Southeast Island. An 18-foot observation tower, 50 oil drums and a dismantled house were left behind. The amphibious vehicle left tracks across the island which persisted for several years. The tread of the vehicle probably carried seeds of the mustard *Brassica* to the island. A major portion of each visit by the Refuge Manager is now spent treating the fast-spreading *Brassica* with herbicides and pulling up new plants.

Midway (3.1 square miles).—Midway is not in the Hawaiian Islands National Wildlife Refuge. It has been a U.S. Naval Station since 1903. It has two major islets, Sand Island, the site of the Naval Air Station, on which 2,000 military personnel reside, and

Eastern Island, which has runways as well, but has in the recent past been used as a large communications base. Midway has had continuous human occupancy since 1903 and is the most altered of the Northwestern Hawaiian Chain. Fairly large numbers of seabirds continue to nest on Midway in spite of the efforts of the U.S. Navy to remove them from some parts of the island. Both albatrosses, which were killed in vast quantities by Japanese plume hunters, increased markedly from U.S. Navy protection, but have declined somewhat in recent years.

Sand Island is officially a bird sanctuary; a \$50 fine accompanies the killing of an albatross, or "gooney," as they are known there. The official posture of the U.S. Navy toward the birds of the island is one of benevolence, yet there is constant conflict between birds, primarily the two species of albatross, and the military's interests in maintaining safe air transport. Cessation of the Early Warning Barrier flights caused air traffic at Midway to decrease sharply in the past few years, and aircraft strikes of birds, once a problem of major dimensions (Robbins, 1966), has declined accordingly. However, the price for decreased air strikes has been the paving over in 1964 of all land 750 feet from the centerline of each of the three runways on Sand Island, necessitating the destruction by asphyxiation of 18,000 incubating albatrosses, 13 percent of Midway's and about 5 percent of the world's population. Recently all active nests on Sand Island's golf course have been destroyed to keep the area open for recreation. Here we have an example of the ethical paradox by which government sanctioned mass killing is permissible, while the same activity conducted on a small scale by individuals is heavily penalized.

Sand Island still maintains large breeding populations of both albatrosses and Red-tailed Tropicbirds. Black Noddies (*Anous tenuirostris*) and White Terns (*Gygis alba*) breed in good numbers in introduced *Casuarina* trees between the barracks. Introduced populations of Canaries (*Serinus canaria*) and Rock Doves (*Columba livia*) have been maintained for many years. Laysan Rails (*Porzanula palmeri*) survived on Midway until 1944. An attempt to reintroduce them to Laysan by Alexander Wetmore in 1923 failed because the vegetation had not yet recovered.

Eastern Island has Midway's remaining populations of frigatebirds and boobies, and a substantial colony of 350,000 Sooty Terns. The Sooty Tern colony relocated on Eastern Island after official harassment programs on Sand Island in 1957 and 1958 chased them off. Unofficial policy, confided several times to POBSP personnel engaged in field work on Eastern Island, was the encouragement of the destruction of Sooty Tern eggs, young and adults. Navy personnel participated in "chick-stamps," and admitted to clubbing adult Sooty Terns from the air with sticks on several occasions. Dogs were brought from Sand Island to Eastern for the express purpose of running them through the incubating albatrosses.

Fisher (1966 and 1970) gives accounts of the destruction of hundreds of albatrosses on Eastern Island from striking guy wires of the antennas of the communications system there. In 1967 the antennas were demolished by explosives and pushed by bulldozers to the sea's edge through the thousands of Sooty Terns then incubating eggs in the antenna fields.

The black rat (*Rattus rattus*) is present on both islands of Midway and probably preys on seabirds and their eggs. Cats are forbidden on Midway.

Kure (0.33 square miles).—Kure is under the jurisdiction of the State of Hawaii. It is a wildlife sanctuary. It has a 4,000-foot runway of packed, crushed coral, and a U.S. Coast Guard LORAN C Station was constructed there in 1960. A complement of 24 Coast Guard personnel is normally present. The LORAN C antenna is a 625-foot tower, guyed by steel cables that fall just short of spanning the island's width. A 70-foot radar

reflector tower is also present. The Coast Guard personnel have not seriously disturbed the breeding sea birds of Kure. Dogs have been kept as pets intermittently, and a pig, scheduled as the prime attraction at a feast, also became a pet, but these have not caused undue damage.

A colony of 25,000 Sooty Terns which became established in 1963 originated, in part at least, from displaced individuals from the harassed Midway population. The populations of Blue-faced Boobies and Hawaiian monk seals have declined historically, the former due to disturbance associated with construction of the antenna, the latter due to repeated disturbance by man and at certain times by dogs.

A squirrel monkey (*Saimiri* sp.) lived free on the island from 1961 to 1967, but rarely disturbed birds.

The Polynesian rat (*Rattus exulans*) population on Kure fluctuates widely from season to season (20–77 rats per acre). Kepler (1967) reports this rat preys on Laysan Albatrosses, Bonin Petrels, Sooty Terns, and Brown Noddies (*Anous stolidus*) on Kure. Bonin Petrels lay up to 500 eggs annually on Kure, but no egg hatched during the five years POBSP personnel were present (Woodward, in press).

Kaula Rock (0.21 square miles).—No account of the Northwestern Hawaiian Chain should omit Kaula Rock. Most accounts do. While it is south of and closer to Nihiu, the westernmost Main Hawaiian island, its avifauna is typical of the Northwestern Chain. The only avifaunal survey of the island was in 1932 (Caum, 1936), and it revealed that Kaula is inhabited by Bonin Petrels, Brown Noddies, Sooty Terns, Blue-gray Noddies, Gray-backed Terns (*Sterna lunata*), White Terns, possibly Black-footed Albatrosses, Bulwer's Petrels, Wedge-tailed Shearwaters, Red-tailed Tropicbirds, three booby species and Great Frigatebirds (*Fregata minor*).

Kaula is under the administrative jurisdiction of the U.S. Department of Navy and has been used as a bombing target by the Navy since 1952. In 1932 a lighthouse was constructed on the summit of Kaula. The construction crew reported the presence of a rat of unknown species on the island.

JOHNSTON ATOLL

Although Calvin Coolidge decreed Johnston Atoll (0.98 square miles) a bird sanctuary in 1926, it was turned over to the U.S. Navy and then to the U.S. Air Force because of its strategic location. Atmospheric nuclear tests were conducted here in the early 1960's.

The appearance of Johnston Atoll has been changed drastically by the demands of U.S. military activities. The largest island, Johnston Island, is 570 acres, 75 percent man-made. Two islets, 24 and 17 acres respectively, are also man-made, while the fourth, Sand Island, supports a U.S. Coast Guard LORAN C Station with a 625-foot antenna, separated from the Coast Guard billets by a long causeway. The antenna guy wires anchor in the ocean around the periphery of this 16-acre island. In spite of human inhabitants and the hazard of the guy wires to bird flight, Sand Island has a large sea-bird colony, all but three species having been chased from Johnston. Eleven species breed on Sand. The Sooty Tern colony there numbers 300,000 birds.

Johnston Island has up to 1,000 human inhabitants, mostly U.S. Air Force personnel. About 60 percent of the island is covered by man-made objects, including an aircraft runway. Black rats, a few cats, and a few dogs are also on the island.

By contrast, Sand Island has a complement of 19 Coast Guard personnel and two to five Air Force personnel. It has no rats, and the pet cats and dogs are normally confined to the end of the causeway away from the seabirds (Kirkpatrick, 1966a). The

attitude of the personnel on Sand Island toward seabirds is largely dependent upon the attitude of their commanding officer. There have been cases of jeeps driven on joy rides through the Sooty Tern colony during incubation. The antenna guy wires kill approximately two dozen Sooty Terns per day at the start of the breeding season when the birds swirl in vast numbers above the island (Shelton, in prep.; A. B. Amerson, Jr., pers. comm.).

LINE ISLANDS

Palmyra (0.82 square miles).—Palmyra is administered by the U.S. Department of Interior. It is presently uninhabited and privately owned. There are dozens of abandoned buildings in various states of repair there. As of 1966 it had no dogs or cats, but black rats were fairly common. It has the largest Red-footed Booby colony in the central Pacific, 25,000 birds, and a Sooty Tern colony of 750,000. Black rats have been observed in the Sooty Tern colony preying on eggs. In 1967 a weather project of the National Center for Atmospheric Research (NCAR) utilized Palmyra. At certain times several airplanes per day were landing on the runway. The runway was scraped to prepare for this activity. The Sooty Tern colony was located in large part on the runway at that time, and wholesale death and nest abandonment occurred. Dead Sooty Terns were to be found in the piles of dirt scraped from the runway. No new population figures are available subsequent to the NCAR Weather Project's use of Palmyra (POBSP, unpubl. reports; R. B. Clapp, pers. comm.).

Washington (ca. 2 square miles).—Washington is administered by the United Kingdom. It has a population of 78 Gilbertese whose income is derived from copra harvest. Cats, dogs, and pigs are kept by the Gilbertese, and feral cats are abundant. Rats, species not determined, are present, but rare. Seabirds are eaten by the Gilbertese. Seabird populations are low, and are restricted to tree-dwelling species. The large fresh-water lagoon is visited by up to 200 ducks annually and was the home of the Washington Island Gadwall (*Anas strepera couesi*), extinct since ca. 1874. The Christmas Island Warbler (*Acrocephalus aequinoctialis*) reaches maximum population here, ca. 2,000, but there are indications that the population may fluctuate considerably. The introduced lorikeet *Vini kuhli* is also present, numbering about 800 (POBSP unpubl. reports; R. B. Clapp, pers. comm.).

Fanning (13 square miles).—Fanning is administered by the United Kingdom. It has a population of 337 Gilbertese who derive their livelihood from copra harvest. The Gilbertese eat seabirds, populations of which are now insignificant. Dogs, cats, and pigs are present under domestication. Black rats are common.

The Christmas Island Warbler once occurred here but appears to be extirpated. The introduced lorikeet maintains a population of ca. 200 birds (POBSP unpubl. reports).

Christmas (124 square miles).—Christmas is administered by the United Kingdom. It supports a population of 400 Gilbertese who work the island's extensive coconut plantations for copra. Nuclear tests were conducted here in 1956 and 1958 by the British and in 1962 by the U.S. In 1960 the administrator made it illegal to catch seabirds, but many are still taken for food. Most seabird species nest on islets within the island's several lagocns. Three of these islets are recognized as important bird sanctuaries, and visits are restricted.

Both Polynesian and black rats are present, along with large numbers of feral cats. In addition hermit crabs (*Coenobita perlitus*) are reported to prey on ground nesting birds here as well. Great Frigatebirds prey heavily on Sooty Tern chicks on Christmas. This practice is not widespread on other central Pacific islands. Large populations of

several species of sea birds are present on Christmas. The island supports the largest population of Sooty Terns in the Pacific, estimated at 25,000,000 birds. The Gilbertese collect as many as 250,000 Sooty Tern eggs for food annually. In one Sooty Tern colony where 500,000 eggs were laid in 1968, one half were gathered by Gilbertese, and most of the remaining hatched, to be eaten by Great Frigatebirds, rats and cats. Only perhaps 25 nestlings, fledged from this colony.

The Lesser Frigatebird (*Fregata ariel*) population on Christmas has declined as a direct result of cat predation, and may be eliminated entirely in the next few years.

The Christmas Island Warbler has a population of about 400 birds, while the lorikeet, introduced repeatedly from Washington Island, was represented by 2 individuals in 1968 (Schreiber and Ashmole, 1970).

Jarvis (1.60 square miles).—Jarvis is administered by the U.S. Department of Interior. It is uninhabited, but an attempt at colonization was made from 1938 to 1940. It was further occupied in 1966 by scientists connected with the International Geophysical Year (IGY). The IGY scientists' house, a few sheds, trash, an old lighthouse, and a tramway are the only signs of human habitation remaining. The settlers brought cats with them, and these now feed on seabirds. Rats formerly occurred on Jarvis but were probably extirpated by cats. POBSP personnel killed over 200 cats in 1964 and 1965, and in later visits in 1967 and 1968 eight or nine were seen in a day or two. Jarvis has a large Sooty Tern colony numbering 1,900,000, and large populations of both frigatebirds and the three boobies, e.g., 9,000 Blue-faced Boobies. Elimination of the remaining cats would make Jarvis among the most important seabird islands of the Central Pacific. There is presently no special protection afforded the birds of this island (POBSP unpubl. reports; R. B. Clapp, pers. comm.).

Malden (7.78 square miles).—Malden is claimed jointly by the United Kingdom and the United States. It is uninhabited, but extensive guano mining took place. The remains of an Atomic Energy Commission camp, set up in 1962 in connection with a nuclear test here, are still apparent.

POBSP killed a herd of five pigs in 1964, and one last pig died in 1967 or 1968. Five cats were seen in 1967, indicative of a very small population. The pigs were evidently responsible for the moderate numbers of most species of seabirds. The size of the guano deposits suggest that this island was at one time a very significant seabird island. No petrels were found on the island, an indication of predation pressure, although islets in the central lagoon, where they might be expected to occur still, were not visited (POBSP unpubl. reports; R. B. Clapp, pers. comm.).

Starbuck (ca. 8 square miles).—Starbuck is uninhabited. It is claimed jointly by the U.K. and the U.S. A few stone buildings remain from the days of guano mining.

Cats and Polynesian rats are present on Starbuck, the former in large numbers. Cats prey heavily on the large Sooty Tern colony (estimated at 2,500,000 birds); about 1,000 adult birds per night were killed by cats during POBSP visits. POBSP personnel killed 120 cats here in 1964 but in 1967 the cat population was still about 150. In 1968 "scattered wings and bodies, and piles of bodies were frequently noted" around the edges of the Sooty Tern colony. Petrels were evidently present once, but no longer (POBSP unpubl. reports; R. B. Clapp, pers. comm.).

Caroline (1.45 square miles).—Caroline is claimed jointly by the U.K. and the U.S. It was used as a coconut plantation until 1943, when it was abandoned after a prolonged drought. Polynesian rats are uncommon and may be restricted to one islet in the atoll. Seabirds attain significant numbers; for example, 10,000 Great Frigatebirds, 5,000 Red-footed Boobies, 500,000 Sooty Terns (Clapp and Sibley, 1971a).

Vostok (0.10 square miles).—Vostok is claimed jointly by the U.K. and the U.S. It is uninhabited. Polynesian rats are abundant. Most of this small island is covered by a *Pisonia* forest. Moderate populations of the representative sea birds, primarily those adapted to nesting in trees, occur (Clapp and Sibley, 1971*b*). Vostok is a relatively unaltered, but simple island ecosystem.

NORTHERN COOK ISLANDS

Penrhyn (6.2 square miles).—Penrhyn is administered by New Zealand but it is claimed both by New Zealand and the United States. Its human population in 1966 was 694. It has extensive coconut plantations, and copra harvesting is the main source of income of the inhabitants. Domestic cats, pigs, and chickens are common, as are rats, species not determined. Most of the few seabirds that inhabit Penrhyn occur on the islet farthest from the village. These are almost exclusively the tree-nesting species, numbers of which are of no great significance (POBSP unpubl. reports; R. B. Clapp, pers. comm.).

TOKELAU ISLANDS

The Tokelau Islands are claimed by New Zealand and the United States, and administered by New Zealand.

There are three islands as follows:

Island	Land area	Human Population in 1966	Cat Population in 1965	Pig Population in 1965
Fakaofu	1.02 sq. mi.	733	40	227
Nukunonu	2.08 sq. mi.	551	30	300
Atafu	0.78 sq. mi.	616	"many"	300

All three islands are devoted to coconut palm culture. All have populations of Polynesian rats and, at times, dogs (Kirkpatrick, 1966*b*). The inhabitants take seabirds for food without restriction; for example, up to 1,000 Brown and Black Noddies are taken by the residents of Fakaofu annually. Palea Islet of Fakaofu has breeding populations of several seabirds, including Sooty Terns, and is undoubtedly the most valuable islet in the group from this point of view. Two landbirds occur, the migratory Long-tailed Cuckoo (*Eudynamis taitensis*), and the Pacific Pigeon (*Ducula pacifica*). The latter is said to have declined from overhunting (Thompson and Hackman, 1968; Wodzicki and Laird, 1970).

AMERICAN SAMOA

American Samoa is an unincorporated territory of the United States, administered by the U.S. Department of Interior. It is composed of six islands as follows:

Island	Land area	Human population in 1970
Tutuila	54 sq. mi.	24,973
Tau	15	540
Ofu	2	412
Olosega	1.5	380
Rose	0.3	0
Swain's	1.25	74

The black rat is found on Tutuila, and may be present on some of the others as well. Polynesian rats have been observed on all islands of this group. There are no legally recognized nature sanctuaries in American Samoa.

The following are the major recent changes in the avifauna of American Samoa. The Sooty Rail (*Porzana t. tabuensis*) from Tau has not been seen in recent years, but the wetland from which it was collected is no longer used for cultivation of taro, and is suspected to be better habitat for the species than in the past. The Mao or Giant Honeyeater (*Gymnomyza samoensis*) has been extirpated from Tutuila, although it still can be found occasionally in Western Samoa. Samoans hunt doves and pigeons avidly, and populations of the Pacific Pigeon are now low. The introduced Red-vented Bulbul (*Pycnonotus cafer*) is now abundant on Tutuila (Clapp and Sibley, 1966; R. S. Crossin, pers. comm.).

The dense interiors of Tutuila and Tau are visited by Samoans only rarely on hunting forays after wild pigs. A recently discovered colony of three and possibly four procellariid species in the mountains of Tau, attests to the relatively unaltered nature of the interior of this island (R. Crossin, pers. comm.).

Rose Island has substantial seabird populations including a Sooty Tern colony (Swerdlhoff and Needham, unpubl. MS). It is uninhabited, has as a predator only the Polynesian rat, and should be given legal status as a sanctuary. Swain's Island, on the other hand, has been inhabited for many years, has Polynesian rats, cats, dogs and pigs (Kirkpatrick, 1966b) and few birds (Clapp, 1968), and would be of little value as a sanctuary.

PHOENIX ISLANDS

Canton (3.5 square miles).—Canton is administered jointly by the U.K. and the U.S. It was inhabited by 500 people up to 1966, when the island was evacuated, and the military base was closed. It was reinhabited by about 200 U.S. Air Force personnel and civilian contractors of the firm Holmes and Narver in 1969, and is now an essential part of a new U.S. missile testing system. About 40 percent of the land area of the island is covered by man-made structures. The Air Force has placed installations on Enderbury and Hull Islands as well, and they have leased Birnie, Gardner, and Sydney from the U.K. but have not yet utilized them. The Air Force, conscious of its "ecological image," requested a consultant from the U.S. Bureau of Sport Fisheries and Wildlife, who advised them on ways of minimizing disturbance of the substantial seabird colonies of these islands, and who laid out guidelines for conduct vis-a-vis natural resources for those stationed on the islands.

Canton has feral cats, dogs, and Polynesian rats, in spite of which three and possibly four procellariids are breeding in small numbers. Red-footed Boobies and Great Frigatebirds formerly nested in the thousands, but are now extirpated because of clearing of the shrubs on which they bred (Clapp, in prep.).

Enderbury (1.95 square miles).—Enderbury is administered jointly by the U.K. and the U.S. The only visible signs of human habitation were a frame house in hopeless repair and a lighthouse until 1970 when Holmes and Narver constructed a 200-foot antenna at one end of the island near a colony of 10,000 Gray-backed Terns, two 40-foot sighting towers at the other end, and a road across the island from their air-conditioned trailer near the antenna to the two towers. Two or three employees are now on the island most of the time. Supplies are brought in by helicopter from Canton. The seabird colonies have not been disturbed unduly by this activity. A few feral cats still are present, descendants of pets brought during an attempt at colonization from 1938 to 1940. Hermit

crabs, in large numbers, have been seen to cause mortality in the large Sooty Tern colony (800,000 birds) and in the frigatebird colonies.

Enderbury is the most important green sea turtle breeding island in the south central Pacific (POBSP unpubl. reports; R. B. Clapp, pers. comm.).

Phoenix (0.16 square miles).—This island is claimed both by the U.K. and the U.S. It has been uninhabited since guano mining days, and the coral rock walls of the miners' houses still stand, providing nesting sites for White Terns and Black Noddies. Phoenix has large populations of all representative seabirds that do not require trees for nest sites. It has five breeding procellariiform species, the largest known Blue-gray Noddy population (10,000 birds) and a Lesser Frigatebird population of up to 45,000 birds.

Phoenix has European rabbits, estimates of which vary from 100 to 1,000. This population is evidently kept in check by periodic harvesting, along with some seabirds, by the crews of copra boats that service the Line Islands (POBSP unpubl. reports; R. B. Clapp, pers. comm.).

McKean (0.13 square miles).—McKean is claimed by the U.K. and the U.S. Rock walls remain from guano mining days; otherwise there are no signs of man's activities. It has no introduced predators. The largest known populations of White-throated Storm Petrels (*Nesofregatta albigularis*) (1,000) and Lesser Frigatebird (85,000) occur here. Populations of the other representative seabirds are large also (POBSP unpubl. reports, R. B. Clapp, pers. comm.).

Birnie (0.10 square miles).—Birnie is claimed by the U.K. and the U.S. It has never been inhabited and is one of the few dry central Pacific islands not to have been mined for guano. Polynesian rats, presumably introduced from an early shipwreck on reefs around the island, are abundant at times. Although populations of seabirds are not high, owing to the small land area, the island has great value because it is nearly in an undisturbed state (POBSP, unpubl. reports; R. B. Clapp, pers. comm.).

Sydney (2.07 square miles).—Sydney is claimed jointly by the U.K. and U.S. It was inhabited by Gilbertese for copra harvest until 1961, when it was evacuated because of prolonged drought. Both Polynesian and black rats occur, and cats and dogs were left behind during evacuation. POBSP personnel killed several cats between 1964 and 1968 but there may still be enough cats to continue reproduction. One dog seen in 1968 may be the last on the island. Seabird abundance is low. In 1968 POBSP observers saw a pre-breeding swirl of roughly 4,000 Sooty Terns above the island. This species was not recorded previously, and may attempt to breed now that the larger predators have been removed or reduced (Clapp and Woodward, in prep. a).

Hull (2.21 square miles).—Hull is claimed jointly by the U.K. and the U.S. The 590 Gilbertese who inhabited Hull were evacuated in 1963. They left behind dogs and cats, of which a few individuals of each are still present, but their reproductive status is unknown. In 1967 the Sooty Tern population was estimated at 3,000,000 birds. Other species, mostly the tree-nesting ones, are not abundant. In 1970 the U.S. Air Force had a 200-foot antenna built on Hull as part of their new missile testing system in the Phoenix Islands. The Sooty Terns are presently not nesting near the antenna. Periodic maintenance visits are made to the antenna by helicopter from Canton (POBSP unpubl. reports; R. B. Clapp, pers. comm.).

Gardner (1.41 square miles).—Gardner is claimed jointly by the U.K. and the U.S. In 1963 the 210 Gilbertese inhabiting Gardner were evacuated because of drought. They left behind cats, dogs, and chickens. Polynesian rats are present. Only low numbers of the tree-nesting seabirds occur here (Clapp and Woodward, in prep. b).

HOWLAND

Howland (0.64 square miles) is administered by the U.S. Department of Interior. It was colonized between 1935 and 1942, and an airstrip and a lighthouse were built, intended for use by Amelia Earhart. Howland was used extensively during World War II by U.S. troops.

The airstrip is now obscured by vegetation. The lighthouse and a few low stone walls remain to tell of human occupancy. Cats, introduced by the colonists, eliminated the once abundant Polynesian rats and then were extirpated in 1964 by POBSP personnel. Cats reappeared in 1966 after a visit to the island by the U.S. Military, and are evidently still present.

Howland has a large Blue-faced Booby population (3,000 birds) and a Sooty Tern population of up to 200,000 birds. Wedge-tailed Shearwaters nest in small numbers in spite of the cats. This island would quickly become among the most significant seabird colonies in the central Pacific if the cats were removed and the island were given protection from disturbance (POBSP unpubl. reports; R. B. Clapp, pers. comm.).

BAKER

Baker (0.53 square miles) is administered by the U.S. Department of Interior. It is uninhabited but was heavily utilized by U.S. troops during World War II. The island was nearly scraped clean of vegetation at that time. Signs of former activities are still evident. The ruins of buildings, trenches, oil drums, metal airstrip matting and a lighthouse still remain. The small lagoon has an islet, on which nest a few Brown Noddies, the only breeding species in 1963. In 1964 the last of a small cat population was removed by POBSP personnel. Within months three species of seabirds previously absent were breeding on Baker, having emigrated from Howland. In 1966 after a visit by the U.S. military at least two cats reappeared on the island, and they are presumably still present (POBSP unpubl. reports; R. B. Clapp, pers. comm.).

Baker has excellent potential as a seabird colony, but it is kept nearly devoid of birds by the presence of at least two cats.

MARSHALL ISLANDS

The Marshall Islands (70.09 square miles) are U.S. Trust Territory administered by the Department of Interior. Land area of the 34 islands ranges from 0.07 square miles (Jemo) to 6.15 square miles (Mili). Eight of the islands are uninhabited. Two of the uninhabited islands, Taongi and Bikar, are too dry to sustain the harvest of coconuts. These are both important seaboard islands. The remainder of the uninhabited and several of the inhabited islands have cats, dogs, pigs, chickens, Polynesian rats and some have black rats as well. Almost all uninhabited islands are devoted to coconut culture. The Marshallese utilize seabirds and their eggs for food. They recognize the importance of affording protection to seabirds to preserve their populations as a renewable resource. They have traditionally considered Taongi, Bikar, Jemo, and islets of Taka and Jaluit as bird sanctuaries, on which the taking of birds and eggs for food is restricted but not prohibited. Taongi and Bikar have at least three species breeding which do not breed on any other island in the Marshalls, and two more that breed only on one other island. Taongi, Bikar, and Jaluit have 11 or more breeding seabird species.

The U.S. Government has conducted nuclear tests on Eniwetok and Bikini. In the long run seabird populations of these islands seem not to have been affected by the explosions. The relative isolation of some islets around the circumference of these large atolls permits the continuance of seabird populations; for example Eniwetok has breeding Sooty Terns

and Red-tailed Tropicbirds in spite of a large human population and the presence of cats and two species of rats on some islets (Amerson, 1969).

WAKE

Wake Island (2.5 square miles) is a U.S. Territory administered by the Federal Aviation Agency. It was occupied by the Japanese during World War II. There are presently about 1,400 U.S. civilian and military personnel on Wake. The island has a long jet strip, radio transmitter and receiver towers, Pacific Missile Range facilities, and a U.S. Coast Guard LORAN Station. The three islets of this atoll are connected by bridges. Feral cats, black and Polynesian rats occur on all three islets. An endemic rail (*Rallus wakensis*) became extinct during World War II. There are eight breeding seabird species; seven more bred in the recent past but have been extirpated. Sooty Terns are the most abundant (1,750,000 birds). Rats prey heavily on the Sooty Terns. Following Typhoon Sarah on 15 September 1967 rat populations exploded. "All fresh eggs disappeared within 24 hours and on two occasions I actually saw rats dragging eggs away while the adult bird stood 'helplessly' watching. We watched several rats chewing on young birds." (R. Schreiber, POBSP unpubl. field notes). By September 1968, after an active rat control project, rats were neither seen nor trapped by POBSP personnel (POBSP unpubl. reports).

CONCLUSIONS AND RECOMMENDATIONS

Most of the islands covered by this survey have been materially altered by man. Isolation is no longer a sufficient deterrent to alteration; in some instances, e.g. military operations, it appears to be a desirable asset. Seabird faunas have experienced wholesale depletion, but have demonstrated remarkable resiliency. Future utilization of these islands is bound to take place, for which reason it is essential to identify and protect those islands with relatively intact avifaunas, and to insist that users pick up after themselves when they have finished with an island, so that its value as a bird habitat is undiminished or improved. The status of fish, invertebrates or plants on some islands is unknown. Special care should be taken to prevent the extirpation of species from islands before they are investigated. Nonscientific visits to such islands should be stringently controlled.

The following islands are considered to be of outstanding value in terms of the diversity or abundance of their avifauna, or because they are in a relatively unaltered or recovered state: Nihoa, Laysan, Lisianski (and the other islands of the Hawaiian Islands National Wildlife Refuge), Christmas, Jarvis, Vostok, Rose, Phoenix, McKean, Birnie, Taongi, and Bikar.

The following are potentially important as bird habitats, but are kept from attaining that importance by one or more factors capable of correction: Kaula, Malden, Starbuck, Enderbury, Howland, and Baker.

To materially improve the bird habitats of the central Pacific, it is recommended:

1. That the U.S. Navy discontinue bombing of Kaula, and surrender jurisdiction of it to the Department of Interior for inclusion in the Hawaiian Islands National Wildlife Refuge.
2. That the U.S. Coast Guard LORAN A Station on French Frigate Shoals be abandoned as soon as other navigational systems render LORAN A obsolete or redundant.
3. That the U.S. Department of Interior remove introduced populations of Nihoa and Laysan Finches from French Frigate Shoals and Pearl and Hermes Reef respectively

since neither of these populations is in "last resort" status on its native island, and their egg-eating habits may exert undesirable effects on the indigenous birds of the islands to which they were brought.

4. That Eastern Island, Midway, be made a strict bird sanctuary by the U.S. Navy, or, preferably, that it be turned over for inclusion in the Hawaiian Islands National Wildlife Refuge.

5. That the U.S. Department of Interior declare Jarvis, Howland, and Baker as National Natural Monuments, and that the Department of Interior seek the cooperation of the Department of Defense in removing the cats placed on Howland and Baker by the latter.

6. That a joint U.S.-British expedition visit islands in the Line and Phoenix Group to remove cats, and, where pertinent, dogs from presently uninhabited islands where they occur. These include Jarvis, Malden, Starbuck, Hull, Gardner, Sydney, and Enderbury. The last four could best be visited through the cooperation of the Air Force, which is currently leasing them. Associated with this recommendation, and of greater importance, is the removal of rabbits from Phoenix Island.

7. That the U.S. Department of Interior take an active hand in the preservation of Taongi and Bikar as bird sanctuaries by legal recognition and by regulation of the taking of birds and eggs by Marshallese commensurate with the principle of sustained yield.

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